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RICE, P.M.

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Imazapic Effect on In-Situ Non-Target Plants

Peter Rice and Steve Sutherland
University of Montana & USFS Rocky Mountain Fire Sciences Lab

This two year project evaluated the first year post spray effectiveness of imazapic (Plateau) on three target weeds and the response of the non-target plant community (Table1).

Table 1. Target weeds at three study sites.

Site Name	Primary Target Weed	Secondary Target Weeds
Middle North Hills (MNH)	Leafy spurge	Dalmatian toadflax
Lower North Hills (LNH)	Dalmatian toadflax	Leafy spurge
Frenchtown West (FTW)	Cheatgrass	Japanese brome, Soft brome

Sixteen permanently marked 0.06 acre plots (40 x 66 ft) were constructed at each of the three sites. Six marked transects with six marked Daubenmire microplots per transect were installed in each plot. Baseline community composition measurements were completed in June and July of 2004. Heavy rains in late August through mid-September 2004 resulted in extensive greenup of all target weed species and native bunchgrasses. Half (eight) of the plots at each site were sprayed in the fall of 2004 at the fall phenological stages believed to be most suitable for the primary target weed at each site (Table 2). Initial responses of the communities were measured in June through early July of 2005.

Table 2. Herbicide treatment schedule.

Site (primary target)	Plateau Rate (oz/ac)	Surfactant Rate	Date	Target Weed Phenological Stage
Middle N. Hills (l.s.)	12	MSO 1 qt/ac	9/21/04	fall greenup, pre-freeze
Lower N. Hills (d.t.)	12	MSO 1 qt/ac	10/27/04	fall greenup, post-freeze
Frenchtown W. (c.)	10	NIS 0.25% v/v	9/15/04	2 to 3 leaf

Spraying significantly ($p<.06$) reduced the canopy cover of all target weeds and secondary targets in the first growing season after spraying at each of the three sites (Table 3). Control of leafy spurge was 97% at the Middle North Hills site, where it was the primary target for the fall green-up pre-freeze treatment. Control of leafy spurge at the Lower North Hills site where it was sprayed at a later post-freeze date was still 89%.

The dalmatian toadflax treatments were less successful. In the Lower North Hills the fall greenup post-freeze treatment provided only 15% suppression of dalmatian toadflax canopy cover, although this late season spray timing was believed to be the optimal stage for this target.

The dalmatian toadflax canopy cover control was actually much better (78%) at the Middle North Hills site where an early pre-freeze spray timing was employed for the primary target leafy spurge.

Suppression of annual bromes canopy cover at the Frenchtown West site was very poor with the reduction for combined canopy cover of the three exotic *Bromus* species being only 45%. Japanese brome (*B. japonicus*) was most suppressed with 76% control relative to the check plots. Soft brome (*B. mollis*) control was just 55%, and the dominant cheatgrass or downy brome (*B. tectorum*) control was even lower at 41%. High amounts of litter at this site may be negating the potential for Plateau to control these annual grasses. Average ground level litter cover by point intercept was 60% when the summer 2004 baseline was measured. It July 2005 there were 782 lb/ac litter, the fall 2004 litter, when sprayed, was likely even higher.

Table 3. Target weed canopy cover in first growing season after spraying Plateau.

Site	Weed	%Canopy Cover		%	
		Check	Spray	Control	p.†
MNH	Dalmatian toadflax	1.3	0.3	78	.001
	Leafy spurge	12.0	0.4	97	<.001
LNH	Dalmatian toadflax	4.9	4.2	15	<.001
	Leafy spurge	9.6	1.1	89	<.001
FTW	Japanese brome	4.3	1.0	76	.023
	Soft brome	0.7	0.3	55	.060
	Cheatgrass	37.0	21.8	41	.038
	Combined annual bromes	42.0	23.1	45	.007

†significance of analysis of covariance treatment factor with pre-treatment value as covariate.

The 89% and 97% first growing season post-spray suppression of leafy spurge canopy cover was very good for this difficult to control rhizomatous perennial in comparison with average control after spraying of established standard treatments using other herbicides at high active ingredient rates (Table 4). However, there were a large number of small resprouts present in June of 2005 at both sites infested with this weed (Table 5). First growing season control of leafy spurge resprouts on a frequency of occurrence basis was just 57% and 60%. Even with initially high rates of picloram leafy spurge typically requires re-treatment to maintain control (Table 4). The active ingredient rate of Plateau at 12 oz (product)/ac is only 3 oz/ac of imazapic, much lower than the picloram rates with equivalent initial efficacy.

Table 4. Examples of leafy spurge control in years after a single herbicide treatment*.

Herbicide	Rate (a.i.) & Timing	1 YAT	2 YAT
picloram	1lb/ac spring	74 (73)	21 (14)
picloram	2 lb/ac spring	96 (110)	82 (26)
picloram	1lb/ac fall	67 (51)	44 (13)
picloram	2 lb/ac fall	80 (38)	82 (13)
picloram + 2,4-D	0.5 + 1.0 lb/ac spring & fall	71 (6)	
picloram + 2,4-D	0.5 + 1.5 lb/ac spring & fall	64 (6)	
picloram + 2,4-D	0.5 + 2.0 lb/ac spring & fall	76 (6)	

(#) number of observations contributing to mean

* Sources: Lym, R.G. & C.G. Messersmith. 1985. Leafy spurge control with herbicides in North Dakota: 20-year summary. J. Range Management 38(2):149-154. & Lym, R.G. & C.G. Messersmith. 1987. Leafy spurge control and herbicide residue from annual picloram and 2,4-D application. J. Range Management (49(3):194-198.

Table 5. Target weed frequency of occurrence in first growing season after spraying Plateau.

Site	Weed	% Frequency of Occurrence		% Control	p.†
		Check	Spray		
MNH	Dalmatian toadflax	40	18	54	<.001
	Leafy spurge	92	37	60	<.001
LNH	Dalmatian toadflax	92	75	18	<.001
	Leafy spurge	93	40	57	<.001
FTW	Japanese brome	76	34	54	<.001
	Soft brome	51	23	55	.020
	Cheatgrass	100	89	11	.048

†significance of analysis of covariance treatment factor with pre-treatment value as covariate

There was also prolific resprouting of dalmatian toadflax in the first growing season post-spray such that the decrease in frequency of occurrence at the Lower North Hills site was only 18% where canopy cover control was so ineffective (only 15%). The 78% canopy cover control of dalmatian toadflax in the Middle North Hills in the first growing season after spraying was acceptable compared to other herbicide prescriptions typically used for this very difficult to suppress rhizomatous perennial (Tables 6 & 7). However the frequency of occurrence of toadflax resprouts in the spring after the fall Plateau treatment of this early fall sprayed site was also very high (Table 5). The control of toadflax resprouts in the first spring post-spray as measured by frequency of occurrence being only 54%.

Table 6. Comparison of picloram and Grazon (picloram plus 2,4-D amine premix) herbicides on dalmatian toadflax control*.

			% CONTROL (data range and average)				
Herbicide	Rate * lb/ai/ac	Appl stage	2-3 MAT (AVG)	1 YAT (AVG)	2YAT (AVG)	3YAT (AVG)	No. trials
Grazon	1.27	FLR		64-85 (75)	43**		2
Picloram	0.25	FLR	46-53 (50)	51-97 (80)			3
Grazon	1.91	FLR		83	77		2
Picloram + X77	0.375	FLR	55-58 (56)	56-100 (88)	60-81 (72)		4
Grazon	2.54	FLR		90	85	83	1
Picloram	0.5	FLR	11-96 (53)	68-100 (91)	58-97 (80)	57**	8
Grazon	1.27	FALL		5-91 (48)	0-87 (43)	13**	2
Picloram + x77	0.25	FALL		2-92 (63)	2-91 (63)	53-81 (67)**	4
Grazon	1.91	FALL		56-96 (76)	97**	11**	2
Picloram + x77	0.375	FALL		12-99 (66)	60-96 (79)**	70**	4
Grazon	2.54	FALL		82-100 (91)	94**	18**	2
Picloram	0.5	FALL		70-100 (88)	68-100 (87)	34-92 (69)**	6

*Source: Celestine Duncan. 2000. Dalmatian Toadflax Literature Review. Weed Management Services, Helena MT.

Table 7. Effect of Picloram in combination with herbicides other than 2,4-D amine (Grazon) on dalmatian toadflax*.

		% CONTROL (data range and average)				
Herbicide	Rate * lb/ai/ac	Appl stage	2-3 MAT (AVG)	1 YAT (AVG)	2YAT (AVG)	No. trials
Picloram	0.25	FLR	46-53 (50)	51-97 (80)		3
Picloram + triclopyr	0.25 + .5	FLR	56-60 (58)	94-100 (97)	58-83 (70)	2
Picloram + 2,4-D ester	0.25 + 2	FLR	56-58 (57)	95-100 (97)	53-62 (58)	2
Picloram + escort+sylg	.25+.038 oz	FLR	88	74		1
Picloram + campaign	.25+1.3	FLR	88	88		1

*Source: Celestine Duncan. 2000. Dalmatian Toadflax Literature Review. Weed Management Services, Helena MT.

Post-spray frequency of occurrence of the annual brome species was also very high with cheatgrass frequency of occurrence only being reduced 11% (Table 5).

The fall Plateau spraying significantly reduced species richness at all three site in the first growing season after treatment (Table 8). Diversity, as quantified by the Shannon –Weaver index using canopy cover for the importance value, was significantly reduced at two sites but not affected at the Frenchtown West cheatgrass site. Frenchtown West was the least diverse pre-spray site based on Shannon-Weaver because of the heavy dominance of cheatgrass which accounted for 57.2% of the relative canopy cover (37.0% absolute canopy cover). Declines in diversity parameters are typical in the first growing season pos-spray for almost all herbicide treatments.

Table 8. Species richness and Shannon-Weaver diversity in first growing season after spraying.

Site & Herbicide	Community Diversity Parameter	Check	Spray	p.†
MNH & 12oz/ac Plateau	Species Richness	27.6	18.1	<.001
	Shannon-Weaver Diversity	2.018	1.668	.009
LNH & 12 oz/ac Plateau	Species Richness	19.8	14.8	.002
	Shannon-Weaver Diversity	1.987	1.877	.028
FTW & 10 oz/ac Plateau	Species Richness	24.1	20.0	.002
	Shannon-Weaver Diversity	1.484	1.667	.586
NH & 2 qt/ac Tordon	Species Richness	31.8	11.0	<.001
	Shannon-Weaver Diversity	2.903	1.933	.006

†significance of analysis of covariance treatment factor with pre-treatment value as covariate.

The Plateau treatments altered flowering development in perennial grasses and some forbs in the first growing season post spray. Bunchgrass height and flowering was suppressed (Figures 1 & 2). It is anticipated that the perennial grasses will outgrow this initial suppression in the second growing season post-spray. Conversely the Plateau stimulated extensive early flowering in at least the native lupine species (Figures 3 & 4). However, the canopy cover of the lupines was not altered in the first growing season post spray (Table 9). This illustrates that in spite of an overall first year post-spray decline in diversity, a number of native broadleaf species are tolerant of Plateau. To obtain an equivalent level of leafy spurge canopy cover suppression

(i.e. 89-97%) would require a two quart/acre (1 lb (a.i)/ac) rate of Tordon, or a multi-pint rate of Tordon plus 1 or 2 quarts of 2,4-D. Both of these high rate leafy spurge treatments would have a much more severe impact on non-target forbs than that which occurred with the Plateau application. For example, in an earlier study located in the same North Hills area as this Plateau study, a fall picloram treatment of 1 lb (a.i.)/ac for leafy spurge control reduced species richness in the first growing season post-spray to only an 11 species mean in the spray plots compared to an average of 31.8 species in the check plots (n=5) (Table 8). Declines in Shannon-Weaver diversity were also much greater after the high rate picloram (Tordon) treatment than after the Plateau treatments. The first year non-target impacts of Plateau at 12 oz (product)/ac (i.e. 3 oz imazapic/ac) as summarized in Table 8 were much less severe than picloram with equivalent target efficacy.

Table 9. Canopy cover of native lupines in the first growing season post-spray at the Middle North Hills site.

Site	Native Forb Species	%Canopy Cover		p.†
		Check	Spray	
MNH	*Lupinus sericeus* + *L. wyethii*	23.6	23.4	.688

†significance of analysis of covariance treatment factor with pre-treatment value as covariate.

Indicator species analysis values were calculated for the 51 species sampled at the Middle North Hills site in 2005, the first growing season post spray. Two native bunchgrass species were significant ($p \leq 0.05$) increasers one growing season after spraying (Table 10). Twelve species were significant ($p \leq 0.05$) decreasers. These decreasers included all three target weeds, one cool season native bunchgrass (*Poa secunda*), one native forb, one exotic perennial grass, five exotic ephemeral forbs, and one additional invasive exotic perennial forb (*Potentilla recta* or sulfur cinquefoil) (Table 10). The sulfur cinquefoil was stunted and numerous plants were chlorotic but appeared to be outgrowing the imazapic injury. Seven species were rated as tolerant to imazapic treatment as the indicator species analysis (ISA) values had a 1:1 ratio for the sprayed and check plots. The tolerant species included 5 native forbs, a native annual grass (*Festuca octaflora*), and the exotic noxious spotted knapweed (Table 11). The results of the first year post spray indicator species analysis for the Middle North Hills site species are graphically summarized in Figure 8.

Indicator species analysis values were calculated for the 43 species sampled at the Lower North Hills site. There were no significant ($p \leq 0.05$) increasers in the first growing season after spraying at this site. Spotted knapweed (ISA value 73, $p=0.078$) exhibited an increasing trend. *Agropyron spicatum* (ISA value 66, $p=0.118$) and *Stipa comata* (ISA value 46, $p=0.363$) had only a weak tendency to increase in the first growing season after spraying the Lower North Hills site although these two native bunchgrasses had increased significantly ($p \leq 0.05$) at the Middle North Hills site. Nine species were significant first growing season decreasers. This Lower North Hills decreasers list had a strong correspondence with the decreasers list for the Middle North Hills. The four species that may be the most tolerant species (i.e. spray:check indicator species ratio closest to ~ 1:1) at the Lower North Hills site are listed in Table 13. These include two large native forbs (*Lupinus sericeus* & *Balsamorhiza sagittata*) which were also rated tolerant at the Middle North Hills site, and dalmatian toadflax which was not well controlled by the post freeze application timing used for the Lower North Hills site.

Table 10. Significant increasers and decreasers in first growing season post spray at the Middle North Hills site.

Increaser Species	**Origin**	**ISA Value***	**Significance**
Agropyron spicatum (AGRSPI)	n	87	.018
Stipa comata (STICOM)	n	81	.017
Decreaser Species			
Draba verna (DRAVER)	e	100	.001
Holosteum umbellatum (HOLUMB)	e	100	.001
Myosotis micrantha (MYOMIC)	e	100	.001
Euphorbia esula (EUPESU)	e	97	.001
Veronica arvensis (VERARV)	e	88	.002
Gaillardia aristata (GAIARI)	n	87	.002
Bromus tectorum (BROTEC)	e	85	.018
Linaria dalmatica (LINDAL)	e	82	.001
Poa bulbosa (POABUL)	e	77	.025
Poa secunda (POASEC)	n	67	.015
Potentilla recta (POTREC)	e	63	.015
Arenaria serpyllifolia (ARESER)	e	60	.019

*Indicator Species Analysis according to Dufrene, M. & Legendre, P. 1997. Species assemblages and indicator species; the need for a flexible asymmetrical approach. Ecological Monographs 67:345-366; Peterson, E.B. & McCune, B. 2001. Diversity and succession of epiphytic macrolichen communities in low-elevation managed conifer forests in Western Oregon. Journal of Vegetation Science 12(4): 511-524.

Table 11. Tolerant species in first growing season post spray at Middle North Hills site.

Tolerant Species	**Origin**	**Sprayed ISA Value***	**No-Spray Check ISA Value***
Lupinus sericeus (LUPSER)	n	50	50
Centaurea maculosa (CEMMAC)	e	46	47
Achillea millefolium (ACHMIL)	n	40	35
Delphinium bicolor (DELBIC)	n	13	13
Festuca octoflora (FESOCT)	n	13	12
Balsamorhiza sagittata (BALSAG)	n	7	6
Penstemon eriantherus (PENERI)	n	6	6

*Indicator Species Analysis according to Dufrene, M. & Legendre, P. 1997. Species assemblages and indicator species; the need for a flexible asymmetrical approach. Ecological Monographs 67:345-366; Peterson, E.B. & McCune, B. 2001. Diversity and succession of epiphytic macrolichen communities in low-elevation managed conifer forests in Western Oregon. Journal of Vegetation Science 12(4): 511-524.

Table 12. Ten most significant decreasers in first growing season post spray at Lower North Hills site (no significant increasers in first post spray growing season at this site).

Decreaser Species	Origin	ISA Value*	Significance
Holosteum umbellatum (HOLUMB)	e	100	0.001
Veronica arvensis (VERARV)	e	100	0.001
Draba verna (DRAVER)	e	99	0.001
Myosotis micrantha (MYOMIC)	e	99	0.001
Euphorbia esula (EUPESU)	e	90	0.001
Potentilla recta POTREC	e	64	0.005
Arenaria serpyllifolia (ARESER)	e	82	0.016
Polygonum douglasii (POLDOU)	n	72	0.025
Bromus japonicus (BROJAP)	e	63	0.027
Bromus tectorum (BROTEC)	e	71	0.082

*Indicator Species Analysis according to Dufrene, M. & Legendre, P. 1997. Species assemblages and indicator species; the need for a flexible asymmetrical approach. Ecological Monographs 67:345-366; Peterson, E.B. & McCune, B. 2001. Diversity and succession of epiphytic macrolichen communities in low-elevation managed conifer forests in Western Oregon. Journal of Vegetation Science 12(4): 511-524.

Table 13. Most tolerant species in first growing season post spray at Lower North Hills site.

Tolerant Species	Origin	Sprayed ISA Value*	No-Spray Check ISA Value*
Linaria dalmatica (LINDAL)	e	46	54
Chrysopsis villosa (CHRVIL)	n	37	47
Lupinus sericeus (LUPSER)	n	17	27
Balsamorhiza sagittata (BALSAG)	n	18	7

*Indicator Species Analysis according to Dufrene, M. & Legendre, P. 1997. Species assemblages and indicator species; the need for a flexible asymmetrical approach. Ecological Monographs 67:345-366; Peterson, E.B. & McCune, B. 2001. Diversity and succession of epiphytic macrolichen communities in low-elevation managed conifer forests in Western Oregon. Journal of Vegetation Science 12(4): 511-524

By October 6, 2005 the first year post-spray leafy spurge regrowth had reached at least four inches long but was showing some herbicide injury with a multi-stem prostrate growth form (Figure 5). The leafy spurge resprouts that were measured in this first growing season post-spray and continuing to green up in the first fall post-spray may allow extensive recovery of leafy spurge canopy cover in the second growing season post spray. Alternatively residual imazapic may suppress these initial resprouts.

Dalmatian toadflax is more likely to continue to recover as the first growing season canopy cover suppression was less successful and there were numerous resprouts. Fall basal regrowth as of 10/06/2005 was up to six inches and did not show signs of herbicide injury (Figure 6). However the 78% suppression of dalmatian toadflax canopy cover in the first year post-spray at the Middle North Hills site is comparable to that (≤90%) typically reported as obtainable by other herbicide prescriptions (Tables 6 & 7) which also have harsher impacts non-target forbs.

The available percent control reports of dalmatian toadflax from the chemical industry are usually obtained by simple visual comparisons of small sprayed plots with adjacent unsprayed check plots, rather than by actual measurement of canopy cover. This typical visual assessment of dalmatian toadflax response may lead to overestimations of the degree of toadflax suppression. The dalmatian toadflax growth form is for heavy, tall, upright stems. Accordingly at intermediate stages of successional degradation of the infested community this invasive weed has low canopy cover values even when it is a co-dominant. Inspection of Figure 7 suggests good suppression of dalmatian toadflax in sprayed plots relative to adjacent check plots at the Lower North Hills site. The Plateau treatment strongly suppressed dalmatian toadflax flowering and stem height, while the flowering and high stems of dalmatian toadflax on the check plots are visually very prominent. This visual only comparison suggests good control of dalmatian toadflax. However direct measurement of canopy cover indicates that although there was statistically significant ($p<.001$) suppression of the dalmatian toadflax this suppression was only 15% relative to the controls.

SUMMARY

Fall applied Plateau at 12 oz/ac with 1 qt/ac of methylated seed oil provided first growing season post-spray leafy spurge canopy control comparable to other herbicide treatments that employ much higher rates of active ingredients. Two sites with dalmatian toadflax were treated with 12 oz/ac rate of Plateau plus 1 qt/ac of methylated seed oil but at different fall timings. The site sprayed in early fall (pre-freeze) had low but acceptable first growing season post-spray canopy cover control in comparison with other standard herbicide prescriptions, but a late fall (post-freeze) Plateau application was not effective on dalmatian toadflax. A fall trial using Plateau at 10 oz/ac with a nonionic surfactant at 0.25% v/v for suppression of cheatgrass and related species was also ineffective. There was a high frequency of occurrence of target weed resprouts in the first growing season post-spray even at the sites with good canopy cover suppression of leafy spurge and dalmatian toadflax.

Statistically significant non-target plant impacts were caused by all Plateau treatments, but the magnitude of the Plateau non-target effects were much less than that resultant from

picloram rates that give equivalent control of the target forb weeds. Also 3 oz (a.i.)/ac of imazapic is much lower environmental loading that the 1 lb (a.i.)/ac or more of picloram or picloram plus 2,4-D that is necessary for equivalent first year control of these two resilient rhizomatous perennials.

Indicator species analysis of community composition in the first growing season post spray showed that several native bunchgrasses were increasers, several native perennial forbs were tolerant of the Plateau treatment, and a larger number of spring ephemeral forbs were decreasers. The target annual brome grasses and the target perennial weeds were generally decreasers except for dalmatian toadflax receiving the late fall post freeze spray timing. Spotted knapweed, which is not controlled by Plateau, was either tolerant or tending to increase. Sulfur cinquefoil was rated as a decreaser at the time of measurement during the first growing season post spray, but this noxious weed was just stunted rather than killed, and appeared to be outgrowing the initial herbicide injury as the season progressed. The full potential to be increasers, decreasers, or tolerant is not likely to be realized until several growing seasons after the herbicide treatment, There are two major effects of spraying, direct injury and release from competition. The consequences of the shift in competition among the species will take several growing seasons to be completely manifested.

The high frequency of first growing season post-spray resprouts of leafy spurge and dalmatian toadflax strongly suggest that repeat treatment with Plateau may be necessary to maintain control. This has been the case for most other herbicides used for controlling leafy spurge and dalmatian toadflax. The plot layout was planned to allow re-treatments as split plots. On October 7, 2005 we re-sprayed half of each plot previously sprayed plot in fall 2004. The herbicide rate for the fall 2005 re-treatment was the same as used in fall 2004, 12 oz/ac Plateau plus 1 qt/ac MSO. PIAP has provided additional funding to measure the 2006 and 2007 entire community response to the single treatments and the two-sequential year treatments (Longer Term Response of In-Situ Native Plants and Rhizomatous Noxious Weeds to Imazapic Grant #06-DG-11010000-0230). The cheatgrass study was discontinued because of the unacceptable low efficacy.

Figure 1. First growing season post-spray suppression of height and flowering of bluebunch wheatgrass in Plateau treated plots; unsprayed area in upper right background; gray stems are previous year flowering stems which provide a relative height reference in contrast with green vegetative culm regrowth and with Figure 2.

Figure 2. Normal height and flowering of bluebunch wheatgrass in no-spray check plots; note bunchgrass height is comparable to adjacent tall dalmatian toadflax stems.

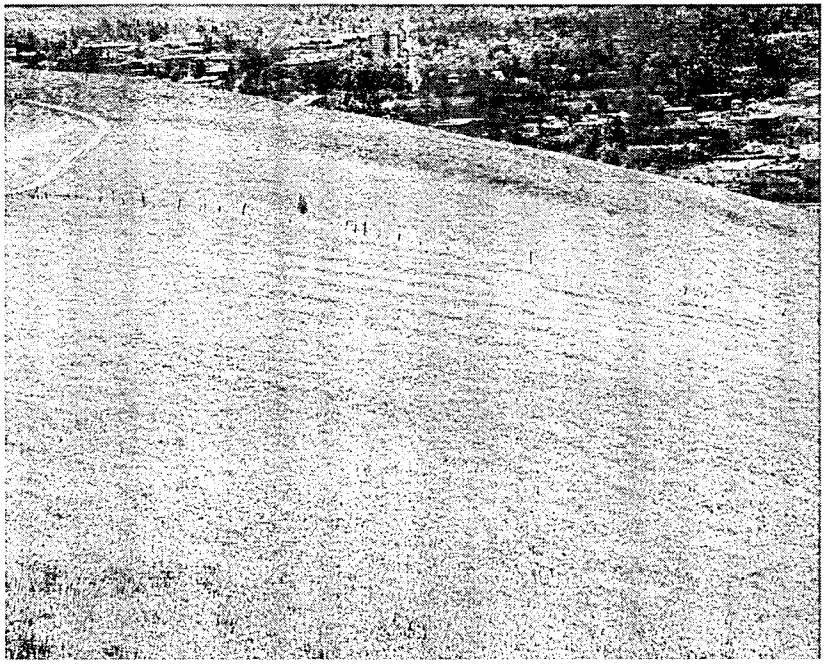

Figure 3. Blue colored native lupines flowering in Plateau sprayed plots interspaced with no-spray check plots still dominated by leafy spurge (May 25, 2005).

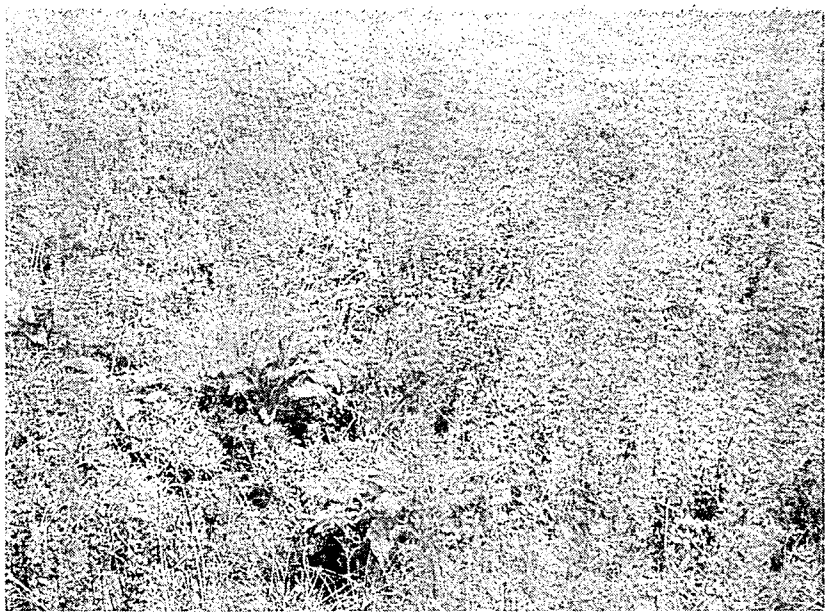

Figure 4. Blue colored native lupines flowering in Plateau sprayed plot (left) contrasted to leafy spurge dominance of adjacent (right) no-spray check plot (May 25, 2005).

Figure 5. Fall 2005 regrowth of leafy spurge in plots sprayed in fall 2004 with 12 oz/ac Plateau + 1 qt/ac methylated seed oil.

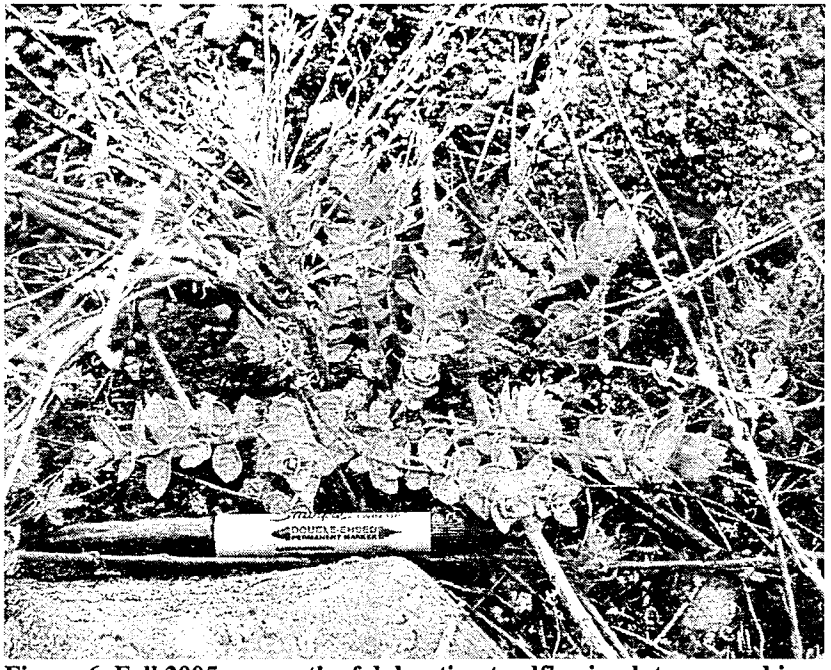

Figure 6. Fall 2005 regrowth of dalmatian toadflax in plots sprayed in fall 2004 with 12 oz/ac Plateau + 1 qt/ac methylated seed oil.

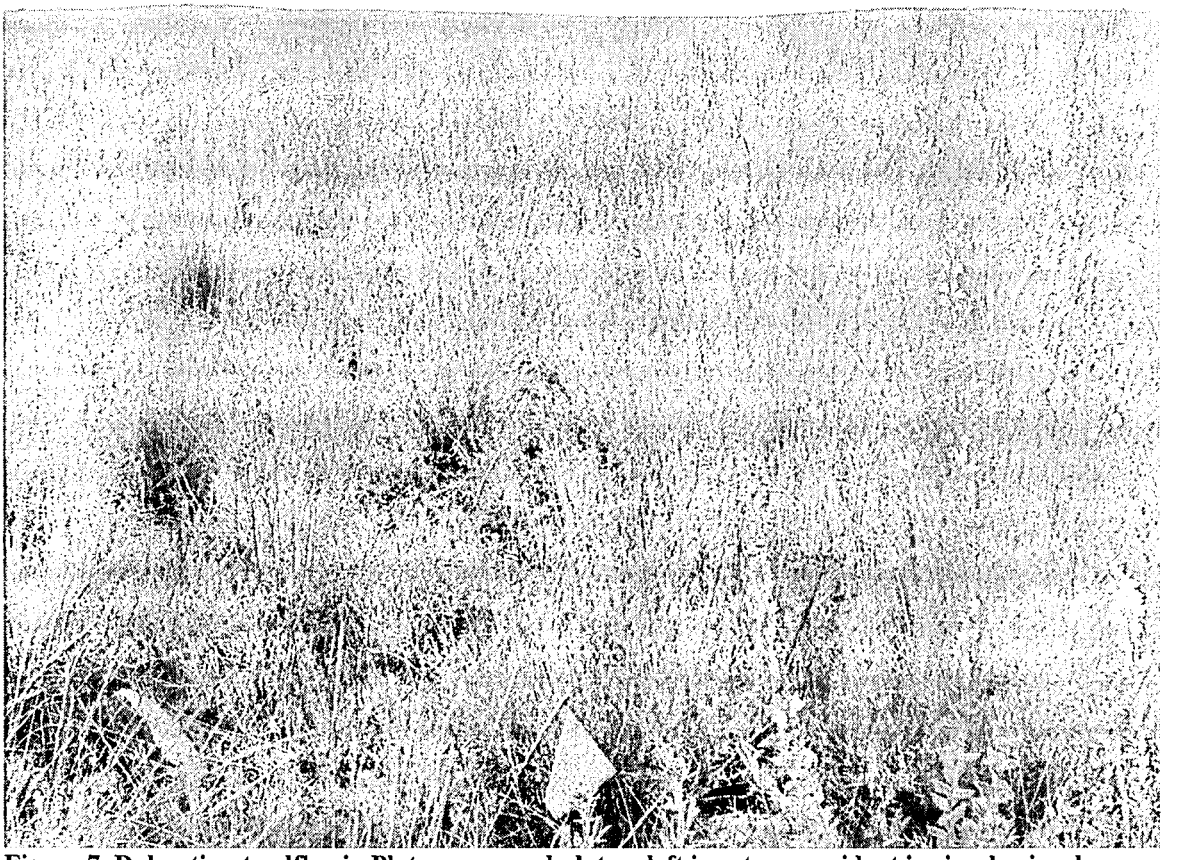

Figure 7. Dalmatian toadflax in Plateau sprayed plot on left is not very evident in simple visual contrast with tall flowering dalmatian toadflax in adjacent (right) no-spray check plot although actual measured canopy did not differ greatly (average 4.2% sprayed plots vs. average 4.9% in check plots); also note relative greater height and current year flowering of bunchgrasses in no-spray check plot.

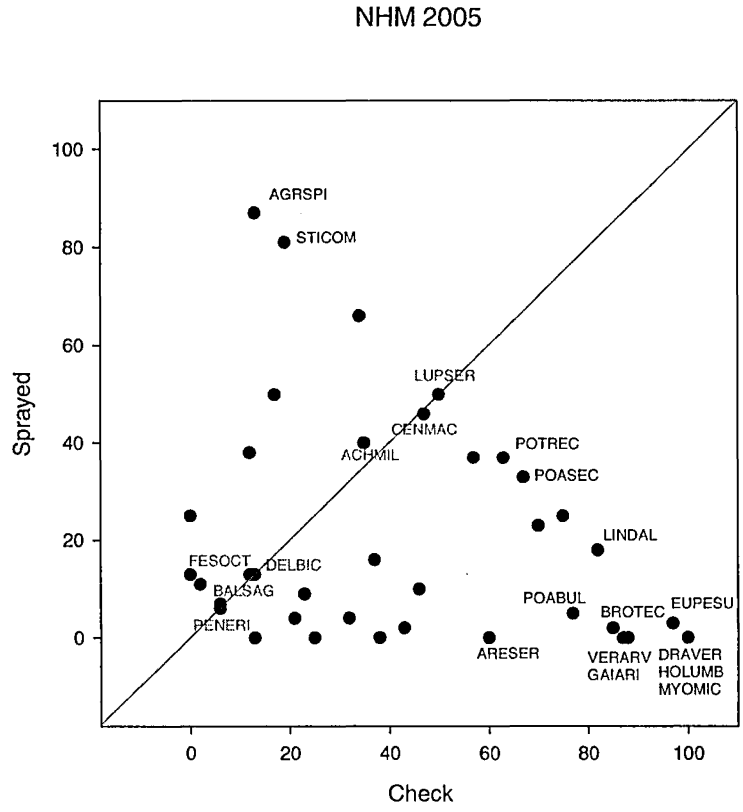

Figure 8. Middle North Hills site imazapic tolerant species (labeled in red) fall on or near the red 1:1 ratio line for the indicator species analysis values for sprayed and check plots, spray increasers fall above this 1:1 line, spray decreasers fall below the 1:1 line; significant (≤0.05) increase or decreaser species are labeled.

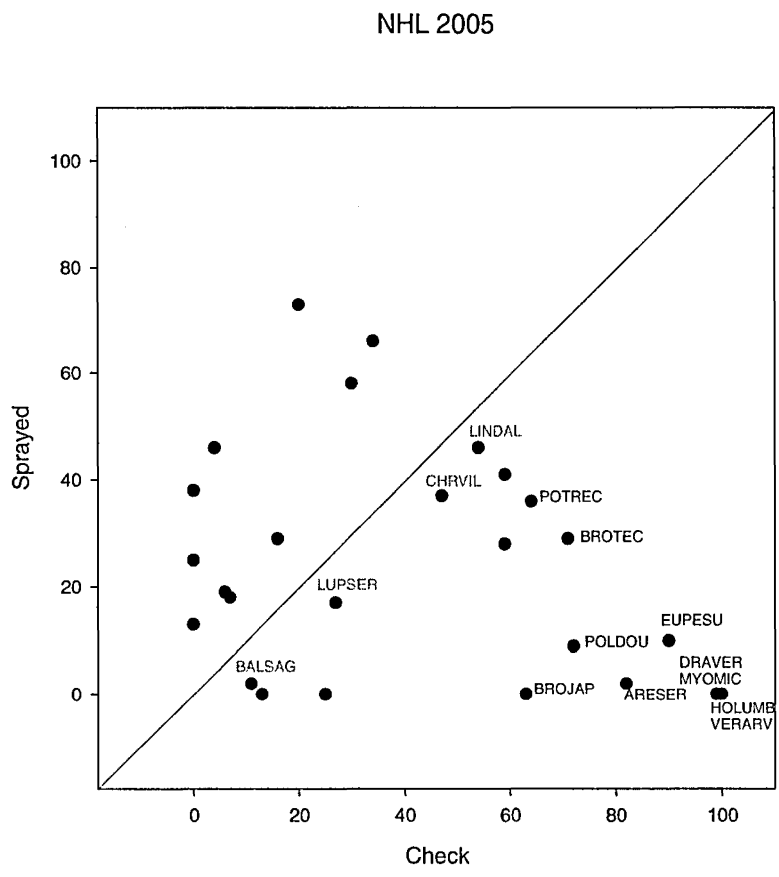

Figure 9. Lower North Hills site imazapic tolerant species (labeled in red) fall on or near the red 1:1 ratio line for the indicator species analysis values for sprayed and check plots, spray increasers fall above this 1:1 line, spray decreasers fall below the the 1:1 line; significant (≤0.05) decreasers species are labeled; there were no significant increasers in this data set.